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ANAEROBIC WASTEWATER TREATMENT FOR REMOVAL OF PHARMACEUTICAL RESIDUES

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INTRODUCTION

Pharmaceutical residues (PR) generally originate from urban-environments, despite partial removal in traditional wastewater treatment systems, they may reach the natural aquatic environment **(Figure1)** at concentrations up to µg/L. Although these concentrations are unlikely to affect human health, they can cause chronic exposure damage to aquatic organisms. Anaerobic digestion (AD) is a potential tertiary treatment stage used to clean up pharmaceutical containing sewage but like any biological process AD can be effected by the presence of PR. The principal aim of this work was to investigate the efficacy of anaerobic wastewater treatment with pharmaceutical loads.

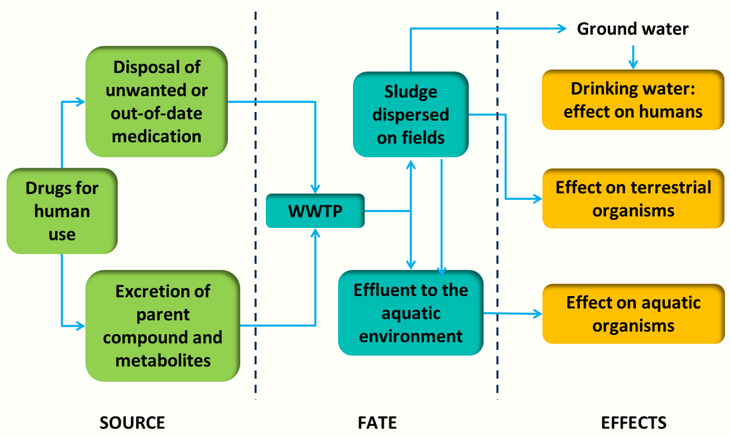

Figure 1. *Occurrence of pharmaceuticals in the environment*

METHODOLOGY

Experimental design

To assess the inhibition of bacteria and biomethanization potential of the organic residues, batch experiments were designed in accordance with ISO 11734 (Figure 2).

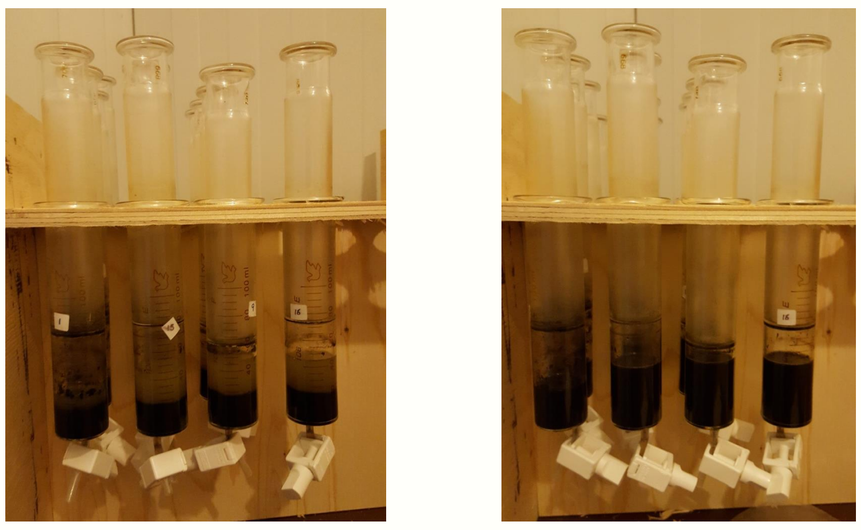

Figure 2. *Batch experiments*

Different operating conditions were tested: temperature (35 *vs* 16°C), substrate organic carbon loading (0.3, 0.8 & 1.6g) and pharmaceutical concentrations **(Table 1)**. Initial preliminary work evaluated caffeine, carbamazepine and lidocaine individually; subsequently combinations of all pharmaceuticals were chosen based on recent literature. With high concentrations primarily found in hospital WW. Polyethylene glycol (7g/L) was also used as reference.

Compound	Low Concentration (µg/L)	High Concentration (µg/L)
Atenolol	0.35	6.03
Bezafibrate	0.035	6.0
Caffeine	0.68	54.7
Ciprofloxacin	0.017	17.5
Clarithromycin	0.04	8.0
Carbamazepine	0.16	0.82
Erythromycin	0.014	2.3
Naproxen	1.1	27.4
Lidocaine	0.07	0.77
Propanolol	0.03	0.51
Simvastatin	0.9	8.5

Table 1. *Low and high pharmaceutical mixtures studied*

RESULTS – Individual compounds

Degradation rates and accumulated biogas productions at 35 °C of all samples are shown in **Figure 3**. The test was considered valid as the reference item was degraded over a 60%.

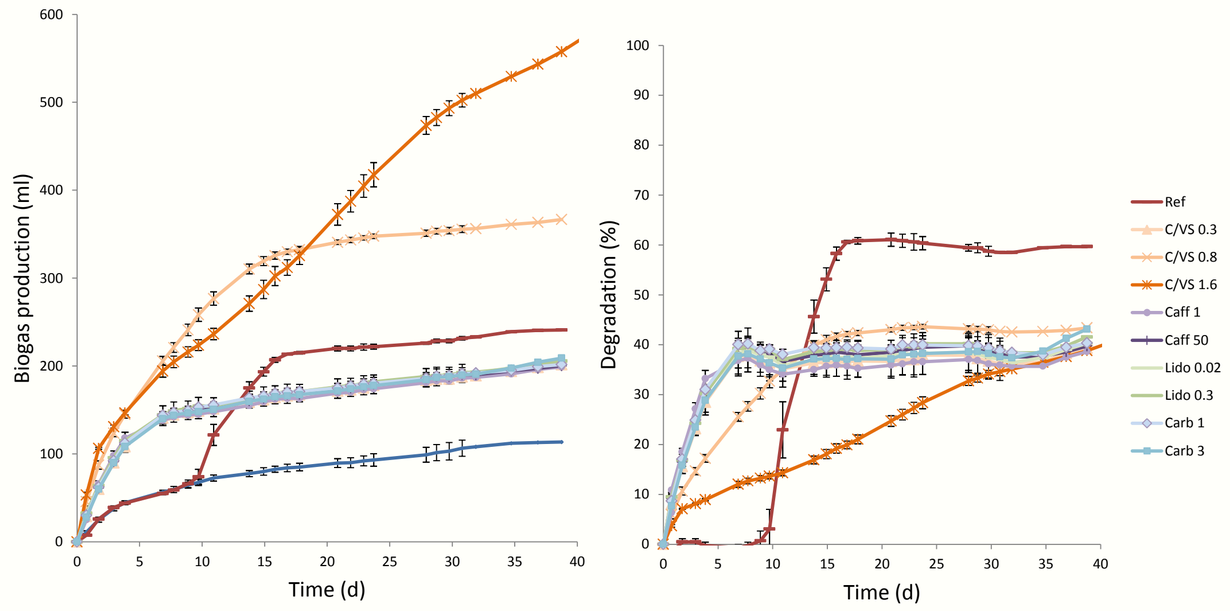

Figure 3*. Accumulated biogas productions and anaerobic degradation rates of samples at 35 °C. Values represent means ± SD (n=3)*

RESULTS – Pharmaceutical mixtures

Preliminary results for the pharmaceutical mixtures, based on 10 days incubation, are presented in Figure 4. Again biodegradation rates and accumulated biogas productions were recorded daily.

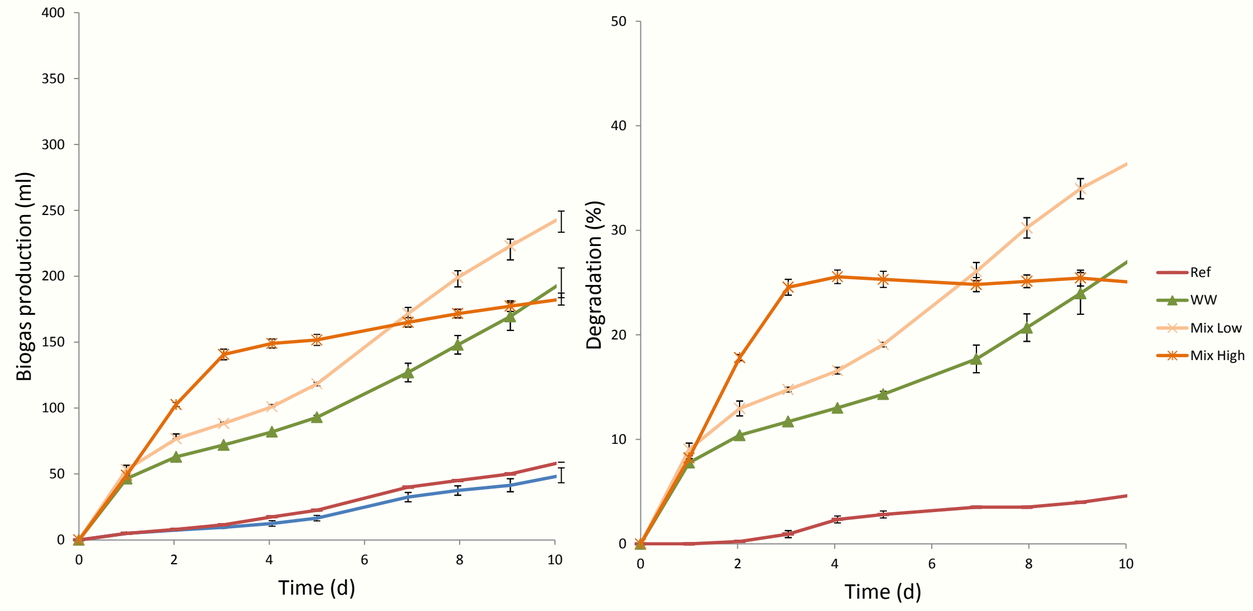

Figure 4. *Accumulated biogas production and anaerobic degradation rates of samples after 10 days at 35 °C. Values represent means ± SD (n=3)*

DISCUSSIONS

- Higher organic loading rates (0.8 and 1.6), produced higher biogas production. However, degradation rates are similar for all OLR (39.3, 43.3 and 41.1% for 0.3, 0.8 and 1.6 ratios respectively). Thus, anaerobic microorganisms do not seem to be affected at high OLR.
- When present individually caffeine, carbamazepine and lidocaine did not appear to effect the degradation of samples.
- Observations during the initial incubation of all pharmaceuticals combined have indicated possible inhibition at high concentrations, whilst low concentrations have appeared to positively influence biogas production.

FUTURE WORK

It is unclear whether the early findings using the pharmaceutical mixture are a result of a single compound or a number of combinations. Future work will investigate the effects of individual and grouped pharmaceuticals to assess the most problematic. Once a suitable concentration has been chosen, all pharmaceuticals will be monitored during long-term continuous treatment.